commonly man himself, very rarely other animals. Both these tapeworms are rather highly specialized and do not appear to be readily adaptable to other hosts. The conclusion seems clear that man has been eating cattle and pigs or their immediate ancestors, and perhaps himself, for as many ages as needed for these tapeworms to attain their present degree of differentiation. We have no evidence that species of any kind are rapidly produced, and the parasites have probably had as slow an evolution as man himself. The fish tapeworm has other definitive hosts than man, notably the dog and the evidence is not conclusive that early man was piscivorous. The ease, however, with which man becomes infested with this parasite might indicate that he had eaten uncooked fish for a long period.

The adaptability of trichina, *Trichinella spiralis,* for man and pigs is rather significant in this connection, but trichina seems to thrive so easily in almost any mammalian host that not much weight can be attached to that parasite as indicating a pork diet for early man.

The idea of the concomitant evolution of these human parasites, of man, and of the animals serving as food for him and intermediate hosts for the parasites has interested me for some time. It has recently been brought to the foreground by Gregory's "Studies on the Evolution of the Primates"[1] in which he so graphically describes (pp. 342–344) the evolution of human food habits. On different grounds from parasitology Gregory concludes that the wild boar was "one of the first medium-sized animals that the nascent Hominidæ would be successful in killing." The only other animal mentioned by him as probable food of early man is the horse. Our knowledge of the beef tapeworm seems to indicate that *Bos taurus* or its progenitors were eaten as well as early horses. There is nothing to show that horses were not eaten, unless the rather widespread abhorence of eating horseflesh at the present time can be construed that man never adapted himself to that diet as he did to beef.

[1] *Bull. Amer. Mus. Nat. Hist.*, Vol. 35, pp. 239–355, June 16, 1916.

It is not beyond possibility that the acquirement of a meat diet by the vegetarian pre-men may by improvement of nutrition, by shortening of digestive processes, and by stimulating properties of proteins and their split-products have played an important part in man's evolution over his vegetarian competitors.

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SCIENTIFIC BOOKS

Napier Tercentenary Memorial Volume. Edited by CARGILL GILSTON KNOTT. Published for the Royal Society of Edinburgh by Longmans, Green and Company. London, 1915. Pp. xii + 422. Price, $7.00.

The International Congress which met at Edinburgh from Friday, July 24, to Monday, July 27, 1914, to commemorate the tercentenary of the publication of John Napier's "Mirifici Logarithmorum Canonis Descriptio" was the last great international assembly of scientists before the Great War. Appreciations of English scientists and congratulatory addresses by German scientists and German universities, in honor of an Englishman, will probably not soon be seen again.

The variety of interests touched by such an invention as logarithms, in its developments, is so well illustrated by the papers of this memorial volume that it seems desirable to present the list.

"The Invention of Logarithms," by Lord Moulton, president of the congress.

"John Napier of Merchiston," by Professor P. Hume Brown, University of Edinburgh.

"Merchiston Castle," by George Smith, master of Dulwich College, formerly headmaster of Merchiston Castle School.

"Logarithms and Computation," by J. W. L. Glaisher, Trinity College, Cambridge.

"The Law of Exponents in the Works of the Sixteenth Century," by Professor David Eugene Smith, Columbia University.

"Algebra in Napier's Day and Alleged Prior Inventions of Logarithms," by Professor Florian Cajori, Colorado College.

"Napier's Logarithms and the Change to Brigg's Logarithms," by Professor George A. Gibson, University of Glasgow.

"Introduction of Logarithms into Turkey," by Lieutenant Salih Mourad, of the Turkish navy.

"A Short Account of the Treatise, 'De Arte Logistica,'" by Professor J. E. A. Steggall, University of St. Andrews, Dundee.

"The First Naperian Logarithm Calculated before Napier," by Professor Giovanni Vacca, University of Rome.

"The Theory of Naperian Logarithms Explained by Pietro Mengoli (1659)," by Professor Vacca.

"Napier's Rules and Trigonometrically Equivalent Polygons," by Professor D. M. Y. Somerville, Wellington University, New Zealand.

"Bibliography of Books Exhibited at the Napier Tercentenary Celebration, July, 1914," by Professor R. A. Sampson, University of Edinburgh.

"Fundamental Trigonometrical and Logarithmic Tables," by Professor H. Andoyer, University of Paris.

"Edward Sang and his Logarithmic Calculations," by Professor C. G. Knott, University of Edinburgh.

"Formulæ and Scheme of Calculation for the Development of a Function of two Variables in Spherical Harmonics," by Professor J. Bauschinger, University of Strassburg.

"Numerical Tables and Nomograms," by Professor M. d'Ocagne, l'Ecole Polytechnique, Paris.

"On the Origin of Machines of Direct Multiplication," by Professor d'Ocagne.

"New Table of Natural Sines," by Mrs. E. Gifford.

"The Arrangement of Mathematical Tables," by Dr. J. R. Milne, University of Edinburgh.

"Note on Critical Tables," by Mr. T. C. Hudson, of the Nautical Almanac staff.

"On a Possible Economy of Entries in Tables of Logarithmic and Other Functions," by Professor Steggall.

"The Graphical Treatment of some Crystallographic Problems," by Dr. A. Hutchinson, Pembroke College, Cambridge.

"A Method of Computing Logarithms by Simple Addition," by William Schooling.

"How to Reduce to a Minimum the Mean Error of Tables," by A. K. Erlang, Copenhagen University.

"Extension of Accuracy of Mathematical Tables by Improvement of Differences," by Dr. W. F. Sheppard.

"Unpublished Tables Relating to the Probability-Integral," by Dr. Sheppard.

"A Method of Finding Without the Use of Tables the Number Corresponding to a given Natural Logarithm," by Dr. Artemas Martin, of the U. S. Coast and Geodetic Survey.

"Approximate Determinations of the Functions of an Angle, and the Converse," by Mr. H. S. Gay, of Shamokin, Pa.

"Life Probabilities; on a Logarithmic Criterion of Dr. Goldziher and on its Extension," by M. Albert Quiquet, general secretary of the Institute of French Actuaries.

In addition to the above scientific papers the volume includes a record of the proceedings of the congress, with a list of the members, and subject and name indices.

Of particular interest is the announcement of new tables, prepared or under preparation, made at this congress. Mrs. Gifford has constructed and published a table to every second of arc of natural sines to eight places of decimals. Such tables will be increasingly in demand since the larger calculating machines are supplanting in many instances logarithms. No little surprise is occasioned by the fact that a mathematician and astronomer of the ability of Professor Andoyer should have devoted several years to the laborious task of computation of tables. The partial fruit of this effort is the publication of the logarithms of the trigonometrical function for every ten seconds of arc to fourteen places of decimals; a large quarto volume of 600 pages, appearing at Paris in 1911. Following this there is in course of publication, evidently delayed by the war, a similar table of the natural functions, to form a quarto volume of about 1,000 pages. Professor Andoyer contemplates further a 14-place table of logarithms of numbers between 100,000 and 200,000. Another set of tables which may be published, and which would render unnecessary the last work mentioned, is the tables of logarithms to fifteen places of the natural numbers from 100,000 to 370,000 by Dr. Edward Sang. The computer resided in Edinburgh where he died in 1890. His tables are accurate to fourteen places, and the manuscript was prepared with such care that it would lend itself admirably to reproduction by photographic processes; to include his tables

of logarithms to 28 figures of the numbers from 1 to 10,000 and to 15 figures of the numbers from 100,000 to 200,000 will require a volume of 1,100 pages.

In the paper by Mr. H. S. Gay the final formulæ are unfortunately incorrectly printed (p. 367). Corrected these should read, as follows:

$$\alpha = \frac{\sin \alpha}{.01147 + .006 \cos \alpha}, \quad \alpha \text{ less than } 45°.$$

$$90 - \alpha = \frac{\cos \alpha}{.01147 + .006 \sin \alpha}, \quad \alpha \text{ greater than } 45°.$$

It is interesting to note that the author, a practising engineer, arrived at his approximate determinations of the sine and cosine by a consideration of first and second differences; similar considerations appear in the earliest tables of sines, in the Hindu Surya Siddhanta and in the work of Aryabhatta, a Hindu astronomer of the sixth century A.D.

The historical notes in connection with the conception and development of logarithms are of real interest. Professor David Eugene Smith discusses admirably the treatment in early works on algebra and arithmetic of the law of exponents. Any careful study of the evidence presented by Dr. Smith will show that the way was being well prepared for the invention of logarithms, so that no surprise need be occasioned by the fact that other claimants to the honor of the discovery have their *patriotic* supporters. Professor Florian Cajori meets in a definite and decisive manner the arguments which have been advanced in favor of the priority in the field of the Swiss writer, Joost Bürgi, sometimes claimed as a German. Cajori says:

> They compare Bürgi's supposed date of invention with Napier's date of publication, and therefrom do not conclude, as they legitimately could, that Bürgi was an independent inventor, but they conclude, as they can not legitimately do, that Bürgi's invention was prior to Napier's, or that Bürgi very probably lost priority simply because of failure to publish his logarithms as soon as invented by him.

This memorial volume is marred by the mistaken efforts to ascribe to Napier the discovery of imaginaries, and the introduction of the decimal point. Numerous writers, notably Cardan and Bombelli, had a much more profound grasp of imaginaries than is anywhere exhibited by Napier. So far as the decimal point is concerned Pitiscus in his "Trigonometry" of 1612 preceded by four years Wright, or Napier, in the use of the comma which appears in Wright's 1616 translation of the "Descriptio" and in Napier's "Rabdologiæ" of 1617; that Napier was familiar with the work of Pitiscus is proved by the fact that in both the "Descriptio" and the "Rabdologiæ" Pitiscus is cited. The spread of the decimal system was greatly facilitated by Napier's adoption, but it is not warranted to ascribe to him any "share in the improvement of decimal arithmetic."

The historical notes (pp. 159–161) to the article on the "De Arte Logistica" are replete with errors. In the dates on the progress of arithmetical and algebraical printing Lucas de Burgo comes first, followed by Cardan with "the next known book." Arithmetics printed before Cadan's work of 1539 occupy 192 pages of Smith's "Rara Arithmetica" while in algebra the well-known works of Grammateus and Ghaligai precede Cardan. Stifel or Stifelius (not Stifellius) did not introduce the $+$, $-$ and $\surd$ signs. Even the English algebra by Robert Recorde is cited as of date 1552, instead of 1557. The concluding remarks to the effect that in Napier's day and for some time afterwards arithmetic and algebra were no part of the mathematical curriculum is absurd. The solution of the cubic and the biquadratic was effected nearly one hundred years before the time of Napier's great publication; Vieta's introduction of literal coefficients preceded by more than twenty years; the serious study of algebra and arithmetic made in the time of Napier prepared the way for the invention of the analytic geometry and the calculus, introducing the era of modern mathematics.

To his contemporaries Napier's most celebrated work was "A Plaine Discovery of the whole Revelation of St. John," published in

1593 and followed by three Dutch editions between 1600 and 1607, by nine French editions between 1602 and 1607, by four German before 1627, and by several other English editions. In this, following the conclusion that the Pope is Antichrist, the end of the world is set to fall between 1688 and 1700. This type of arithmetical mysticism in the study of "Revelations" appealed to many other mathematicians of the sixteenth and seventeenth centuries, some of whom were not so wise as to set the end of the world sufficiently distant to be safe.

From the time of the earliest known trigonometrical tables of Hipparchus and Ptolemy, probably based upon Babylonian documents, down through the ages there has been a continued interest in such mathematical tables. The Babylonians, the Greeks, the Hindus, the Arabs, the Europeans of the Middle Ages, and many of the nations of the present day have contributed energetic workers to this field. No one can deny to Napier the just claim to having made the greatest contribution for the final construction of tables sufficient for computation purposes of the most diverse types.

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A NEW TRIANGULATION SIGNAL LAMP

State, county and city surveyors must look to the national government for the exact geographical positions upon which to base their respective surveys. The duty to establish and furnish these positions devolves upon the United States Coast and Geodetic Survey.

The geodesist determines astronomically with the greatest possible exactness the longitude and latitude of selected principal points, suitably distributed over the whole country. The geographical positions of the many places between these principal points required are ascertained most accurately and economically by means of what is called triangulation. A rough, preliminary or reconnaisance survey reveals those points which are intervisable and most desirable as to distance and other characteristics, to form the corners of connected triangles. From the measured length of one side of a suitably selected one of these triangles and the angles of all the interconnected ones, the exact latitude and longitude of each point is computed.

Though the general principle employed in the measurement of these angles is the same as that applied in the survey of a railroad, a farm, etc., the great distance between the points, varying between ten and a hundred miles or over, requires not only the use of specially large and refined instruments, but also a special means of making the point visible to the observer. This latter is now done, in day time, by reflecting sunlight to the observer from a mirror placed accurately over the point, and at night by means of a specially constructed acetylene lamp.

It is apparent that distances of the magnitude mentioned can be penetrated by either means only under favorable weather conditions, and that many days during a season are lost even when the atmosphere is only slightly clouded by smoke, fog, etc. As the expense to maintain the party, which amounts to from \$50 to \$60 per day, goes on whether observations are made or not, it was thought that advances in illuminating devices made since the lamp now used was adopted might be utilized to increase considerably the intensity of the light directed to the observer, and thereby increase the number of observing nights.

Experiments made with calcium light produced by the oxy-acetylene flame showed this form of illumination to be impracticable by reason of cost and bulkiness of the apparatus necessary.

The storage cell was studied with the view of using electricity as a source of light. Its cost and weight and the difficulties connected with its maintenance were found to be too great. The electric generators with the necessary prime motor were carefully studied, tried experimentally and found to be too heavy for transporting to difficult stations, and doubtful as to continued and unfailing service.

The result of a series of tests of dry cells, which are readily divisible into loads suitable for climbing difficult ascents, however, warranted the design and construction of a new